



Lyndon B. Johnson Space Center, Houston, Texas

ISS Exercise Countermeasures

April 2001

Summary of International Space Station Exercise Countermeasures



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Pre-flight	
Training Program	Optimization of Muscle and Bone
In-flight	
-Treadmill Vibration Isolation System (TVIS)	Preserve an / aerobic power
-Cycle Ergometer Vibration Isolation System (CEVIS)	Preserve aerobic capacity
-interim Resistive Exercise Device (iRED)	Preserve strength & bone mineral
-Handgrip equipment	Preserve hand strength for EVAs
Post-flight	
Rehabilitation Program	Progressive build up of body loss areas
Phased return to duty	Minimize injury/accident risk



In-flight Exercise Countermeasures Hardware

Exercise Countermeasure Equipment is part of the Crew Health Care System (CHeCS)

- **Functional performance requirements for this equipment is documented in SSP 50470, CHeCS GFE Specification**
 - » **iRED, Section 3.7.16.1**
 - » **CEVIS, Section 3.7.11**
 - » **TVIS, Section 3.7.25**
- **CHeCS equipment is managed by the Government Furnished Equipment Office (Code OX) within the ISS Program**
 - » **Developed under NAS9-97029 to Wyle Laboratories**



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	TVIS	iRED	CEVIS	EVA HW
Aerobic/anaerobic training	XXX	X	XXX	
Neuromotor conditioning (coordination, muscle tone)	XXX			
Axial high-impact skeletal loading	XXX			
Strength/endurance training of postural muscles	XX	XXX	X	
Skeletal muscle strength/endurance training	X	XXX	X	
Axial high-strain skeletal loading		XXX		
EVA arm exercise training		XX	XXX	
EVA handgrip strength training				XXX
EVA 2-hr prebreathe exercise countermeasure			XXX	
Aerobic/Anaerobic fitness assessment	X		XXX	
EVA arm ergometry assessment			XXX	

Requirements documented in SSP 50260: ISS Medical Operations Requirements Document



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Nominal In-flight Exercise Prescription

Aerobic Conditioning

2 days/wk
1 TVIS, 1 CEVIS
1 hour each session

Resistive Training

6 days/wk
6 protocols
1 hour each session

Interval Training

4 days/wk
3 TVIS, 1 CEVIS
3 protocols
1 hour each session

Additional EVA training

arm ergometry
hand exercises



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TVIS

- **As a Countermeasure**
 - Ambulation trainer (neuromuscular patterning)
 - Endurance exercise of postural musculature
 - Axial, high impact skeletal loading (bone maintenance)
 - Aerobic exercise
- **For Fitness Evaluation**
 - Backup for the CEVIS and Velo-ergometer (CEVIS nominal, Velo. 1st backup device) for 30-day Physical Fitness Evaluation
- **Contingency Option: CEVIS or Velo-ergometer**
 - Provide aerobic/anaerobic exercise countermeasure
 - Does not provide ambulation training
 - Does not provide axial skeletal loading
 - Does not provide endurance exercise for trunk postural muscles

TVIS

(Treadmill with Vibration Isolation System)



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TVIS

(Treadmill with Vibration Isolation System)





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CEVIS

- **As a Countermeasure**
 - Aerobic/anaerobic exercise countermeasure
 - Maintenance of lower body muscular endurance
 - EVA arm exercise training
 - EVA 2-hr pre-breathe exercise countermeasure
- **As an Assessment Tool**
 - 30-day Physical Fitness Evaluation
 - EVA Arm ergometry assessment test
- **Contingency Option: Russian provided Velo-Ergometer**
 - Provide aerobic/anaerobic exercise countermeasure
 - Provide muscular endurance countermeasure
 - Not appropriate for PFE
 - » Low setting too high for PFE protocol
 - » Inappropriate exercise intensity resolution
 - Not appropriate for EVA pre-breathe exercise
 - » Low settings too high for ramping protocol
 - » Inappropriate exercise intensity resolution

CEVIS

(Cycle Ergometer with Vibration Isolation System)





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iRED

(interim Resistive Exercise Device)

- **As a Countermeasure**
 - training for muscle strength and endurance of all major muscle groups
 - Core exercises emphasize strength and endurance of postural muscles
 - Maintenance of skeletal muscle mass and volume
 - High-strain skeletal loading (bone maintenance)
- **Contingency Option: CRES (contingency resistive exercise system), Russian expanders**
 - Does not provide sufficient force during axial loading for bone maintenance
 - Reduced range of motion against resistance compared to iRED



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Resistive Exercise Daily Workout

iRED

This program is written with the intent to perform lower body exercises everyday.
It also is written to minimize the iRED reconfiguration time for the crewmember.

Day 1

deadlift
bent over rows
straight leg deadlift
squat
heel raises

Day 3

squat
heel raises
straight leg deadlift
deadlift
bent over rows

Day 5

deadlift
bent over rows
straight leg deadlift
squat
heel raises

Day 2

shoulder press
rear raises
front raises
hip abduction
hip adduction

Day 4

bicep curls
tricep kickbacks
upright rows
hip flexion
hip extension

Day 6

shoulder press
lateral raises
front raises
hip abduction
hip adduction



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Resistive Exercise Daily Workout

(Proposed Length of ISS Increment 1 is approximately 4 months.)

6 weeks	Hypertrophy	12-15 reps/2-3 sets to failure
4 weeks	strength endurance	8-10 reps/2-3 sets
4 weeks	strength	6-8 reps/2-3 sets
2 weeks	power	4-6 reps/2-3 sets

This model is mainly for the core (multi-jt.) exercises (Days 1,3,5). The single joint exercises (Days 2,4,6) could stay at 6/8 to 10/12 repetitions.

iRED

(interim Resistive Exercise Device)



Contingency Resistive Exercise System

